Bird Populations 11:14-21

TRENDS IN VAGRANT CAPTURE RATES AT A COASTAL CALIFORNIA BANDING STATION (1993-2010)[1]

MIKE M. STAKE[2]
Ventana Wildlife Society
19045 Portola Dr., Suite F-1
Salinas, CA 93908

Abstract. While monitoring riparian songbirds during 18 years (1993-2010) at a banding station at Big Sur, along the central California coast, Ventana Wildlife Society opportunistically captured 311 vagrants of 50 species. A negative trend in capture rates for vagrants was apparent during that period. Vagrants with a northern North American distribution declined significantly, whereas vagrants with a southeastern distribution did not decline. The decline was evident for fall, but not spring, vagrants. Vagrant trends in California might be associated with trends in source populations, but multiple factors, including a reduction in sampling effort, might have affected vagrant capture rates at Big Sur.
Key words: California, bird banding, population trends, rare birds, vagrants

TENDENCIAS EN TASAS DE CAPTURA DE AVES TRANSEUNTES EN UNA ESTACION DE ANILLAMIENTO DE LA COSTA DE CALIFORNIA (1993-2010)

Resumen. Durante el monitoreo de aves de ribera entre 1993 y 2010 en una estación de anillamiento en Big Sur, en la costa central de California, la Ventana Wildlife Society capturó de forma oportunista 311 transeúntes de 50 especies. Detectamos una tendencia negativa en las tasas de captura de transeúntes durante este periodo. Los transeúntes con distde forma significativa, mientra que aquellas con distribución en el sudeste no declinaron. El declive fue evidente para los transeúntes otoñales pero no los primaverales. Las tendencias de transeúntes en California pueden estar asociadas a tendencias en las poblaciones de origen, pero múltiples factores, como la reducción en esfuerzo de muestreo, pueden haber influenciado las tasas de captura de transeúntes en Big Sur..
Palabras clave: California, anillamiento, tendencias poblacionales, aves raras, transeúntes.

INTRODUCTION

In recent decades, a substantial accumulation has occurred of vagrant landbird records, especially in coastal states, such as California (Shuford 1981). Since 1997, the California Bird Records Committee (CBRC) has annually considered more than 200 reports of rare birds on the state review list (CBRC website, http://californiabirds.org). As a result, the California bird list expanded from 613 in 1997 (Rottenborn and Morlan 2000) to 641 in 2008 (Pike and Compton 2010). A variety of factors have facilitated more frequent observations and reports of vagrants, including an increase in the popularity of birding, improved communi-

[1]Received 15 July 2011; accepted 26 Dec 2011
[2]E-mail address: mikestake@ventanaws.org

cations technology, the growth of long-term monitoring programs, and expanded coverage of field guides to include more information on potential vagrants.

Vagrant studies have greatly improved our understanding of avian distribution and the reasons birds disperse outside of their normal range. DeSante (1983) suggested that vagrants are not necessarily disoriented, but strongly misoriented, or oriented in the wrong direction. Mirror-image misorientation likely prompts many northern and eastern migrants to occur in California (DeSante 1973).

Vagrant reports have also become useful for studying or interpreting source population dynamics. DeBenedictis (1971) was among the first to associate records of vagrants in California with the size of source populations. Veit (2000) linked reproduction for several western passerines with vagrancy of these species in Massachusetts. Patten and Burger (1998) found that spruce budworm (*Choristoneura fumiferana*) density, which affects bird populations in northern forests (Venier et al. 2009), was an excellent predictor of vagrant occurrences for three warbler species in California.

The extent to which vagrant trends are associated with source populations requires additional study, because few investigations have quantified rates of vagrant occurrences over time. Determining vagrant trends can be complicated because the rate at which vagrants are recorded might be heavily influenced by variability in search effort and coverage. Records clearly indicate influxes of vagrants during some years in California (e.g., 1974: Shuford 1981; 1992: Patten and Marantz 1996), but the number of records might poorly represent actual trends over a number of years. DeSante (1983) used consistent netting and censuses on Southeast Farallon Island, California and reported an increase in vagrants during a five-year period in the mid-1970s, particularly for northern vagrants. However, there has been little work on vagrant trends since that time.

Long-term banding projects offer strong potential for studying vagrant trends, because vagrant capture rates can be quantified for a consistent sampling area while accounting for level of effort. I determined trends in vagrant capture rates, using 18 years of standardized mist net data (1993-2010) from the Ventana Wildlife Society banding station near Big Sur, California (formerly the Big Sur Ornithology Lab). Located along a major songbird migration corridor near the mouth of the Big Sur River on the central California coast, the banding station was established to monitor populations of riparian songbirds. During 18 years of operation, Ventana Wildlife Society captured 170 bird species, 50 of which were considered vagrants. These vagrants were typically migrants, especially warblers and vireos, of northern or southeastern North American breeding distribution, but several species of southwestern and palearctic distribution were also captured. My objectives were to determine a trend in vagrant capture rates, and trends between seasons and among regional groups.

METHODS

Ventana Wildlife Society conducted mist-netting at Andrew Molera State Park (36°17′N, 121°50′W) in Big Sur, Monterey County, California. The banding station was located along the Big Sur River approximately 1.5 km from the river mouth. Twenty-one nylon mist nets (12 m x 2.6 m, 30-mm mesh) were used in or adjacent to riparian woodland thickets; several nets bordered coastal scrub. Nets remained in the same locations for the duration of the study. Predominant tree species included Western Sycamore (*Platanus racemosa*), Black Cottonwood (*Populus trichocarpa*), California Bay Laurel (*Umbellularia californica*), Arroyo Willow (*Salix lasiolepis*), and Red Alder (*Alnus rubra*). The coastal scrub plant community included Western Poison-oak (*Toxicodendron diversilobum*), Coyote Brush (*Baccharis pilularis*), Coffeeberry (*Rhamnus californica*), and California Sagebrush (*Artemisia californica*).

The banding station was operated year-round during most years, with more banding days in spring and fall than in summer or winter. Due to funding constraints, banding effort decreased incrementally during the study period, dropping from an average of nearly 300 banding d yr^{-1} in 1994-2000, to about 200 d yr^{-1} in 2001-2007, and <100 d yr^{-1} in 2008-2010. During the final three years, the banding station was not open in the winter. On banding days,

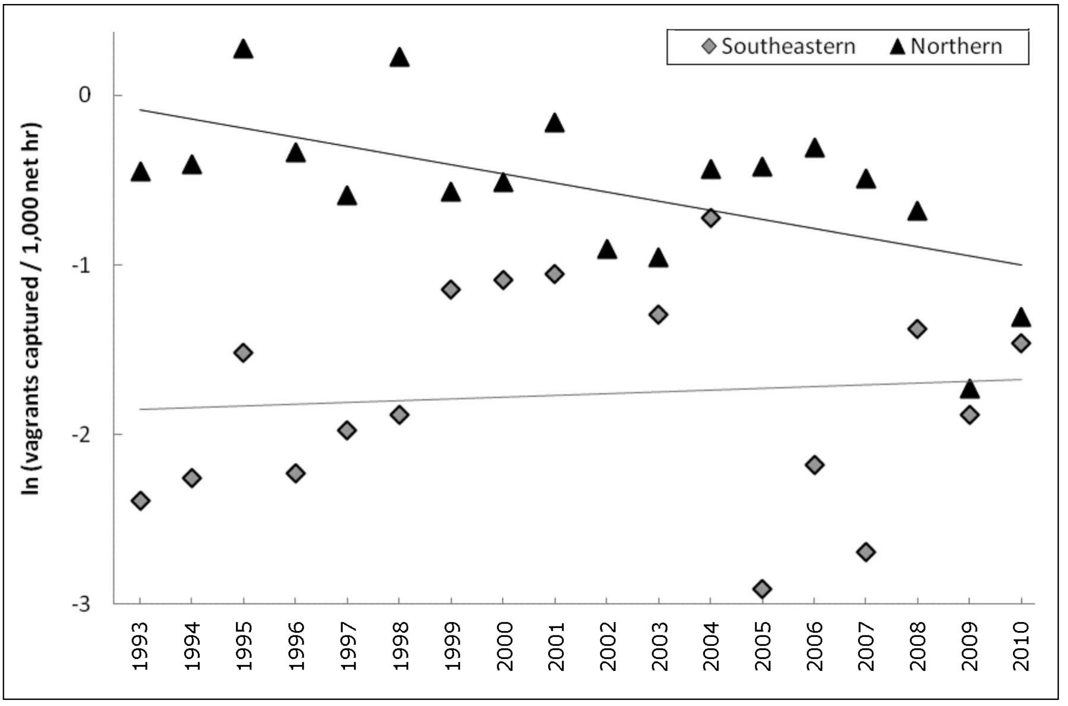

FIGURE 1. Trends in capture rates for southeastern (P = 0.61) and northern vagrants (P = 0.01) at Big Sur, California from 1993 through 2010.

biologists opened nets about 15 min after sunrise and closed nets about five hours later. Nets were not open when there was rain or excessive wind. Captured passerines and near-passerines, including vagrants, were banded and released at the station. Banders determined the age of captured birds as hatching-year or after-hatching-year, based on plumage characteristics, molt study, and the degree of skull pneumatization (Pyle 1997). Many after-hatching-year birds in spring and summer were further classified as second-year or after-second-year.

I considered a vagrant to be a bird outside of its normal breeding, wintering, or migrating range (Appendix 1). I included several rare California breeders or migrants as vagrants (e.g., Northern Parula, *Parula americana*; American Redstart, *Setophaga ruticilla*) because I considered Big Sur, California to be outside of their typical range, or because they were considered to be vagrants when the study began. My classification of species as vagrants was consistent with descriptions provided by Roberson (2002) and groupings by Taylor et al. (1994). I excluded one capture of a palearctic species, Great Tit (*Parus major*) on 17 June 2003 (and recaptured on 5 August 2003), because all other California records were presumed escapees, and none were accepted by the California Bird Records Committee (2007). I also excluded an adult male Painted Bunting (*Passerina ciris*) that appeared to be an escapee, based on patterns of feather wear. I categorized vagrants as northern, southeastern, southwestern, and palearctic (Appendix 1), based on general regions of source breeding populations, similar to those used by DeSante (1983).

STATISTICAL ANALYSES

To standardize the number of vagrants captured among years, annual capture rates were calculated, expressed as the number of vagrants captured net hr^{-1} (x 1,000). I excluded records of recaptured vagrants originally banded at the station; therefore all individuals were sampled only once. Linear regression in SYSTAT 13 (SYSTAT Software, Inc., Chicago, IL) was used to determine a trend in annual capture rates for vagrants from 1993 through 2010. Capture rates were log-transformed to improve normality of the residuals. I determined trends in annual capture rates for all vagrants, regional categories of vagrants, and spring and fall vagrants. Vagrants captured in April, May, and June were considered to be spring vagrants, and vagrants captured in August, September, and October to be fall vagrants. Linear regression was also used to determine trends for all captures combined at Big Sur and the proportion of captured birds that were vagrants. I considered trends statistically significant if $P<0.05$.

RESULTS

Ventana Wildlife Society captured 311 vagrants of 50 species at Big Sur, and vagrants accounted for 0.5% of all new captures. Most were categorized as northern (n = 229, 74%) or southeastern (n = 65, 21%) vagrants. Rose-breasted Grosbeak (*Pheucticus ludovicianus*), Blackpoll Warbler (*Dendroica striata*), Black-and-white Warbler (*Mniotilta varia*), Magnolia Warbler (*D. magnolia*), and Northern Water-thrush (*Seiurus noveboracensis*) were among the most frequent northern vagrants; Hooded Warbler (*Wilsonia citrina*) and Northern Parula were among the most frequent southeastern vagrants (Appendix 1). Relatively few southwestern (n = 15, 5%) and palearctic (n = 2) vagrants were captured. Palearctic vagrants consisted of one Arctic Warbler (*Phylloscopus borealis*, 13 September 1995) and one Dusky Warbler (*P. fuscatus*, 2 October 2004). Most vagrants were captured during fall (n = 167, 54%) or spring (n = 111, 36%). Young birds accounted for the majority of vagrant captures; hatching-year birds accounted for 87% of all vagrants aged during fall, and second-year birds accounted for 68% of all vagrants aged during spring.

Significant negative trends in capture rates were apparent for vagrants and the proportion of vagrants captured at Big Sur from 1993 through 2010, whereas capture rates for all bird species combined did not decline (Table 1). Vagrant captures were particularly infrequent during the final two years when banding effort was lowest. Capture rates for northern vagrants declined significantly, but were stable for southeastern vagrants (Table 1). I did not calculate trends for southwestern or palearctic vagrants due to small samples. Capture rates for fall vagrants declined, whereas capture rates for all bird species during fall were stable. Capture rates were stable for spring vagrants.

DISCUSSION

Big Sur is one of several sites near the California coast where numerous vagrant birds have been recorded. Exceptional vagrant numbers and species richness have been recorded at Southeast Farallon Island, west of San Francisco (DeSante and Ainley 1980). DeSante (1983) reported that vagrants accounted for 4% of all fall migrants and more than 5% of all spring migrants at Southeast Farallon Island from 1968 through 1978. The proportion of vagrants at Big Sur, by contrast, was < 1% of migrant captures in both spring and fall. The rate of vagrant occurrences in California might have changed since the

TABLE 1. Regression statistics for the relationship between capture rate (birds caught net hr^{-1} x 1000) and year for vagrants at Big Sur, California, 1993 - 2010.

Category	Coefficient	SE	r^2	*P*
Vagrants	-0.03	0.02	0.23	<0.05
All vagrants and non-vagrants	0.01	0.01	0.10	0.20
Proportion of vagrants	-0.04	0.02	0.29	0.02
Northern vagrants	-0.05	0.02	0.36	0.01
Southeastern vagrants	0.02	0.03	0.02	0.61
Fall vagrants	-0.06	0.03	0.30	0.03
Spring vagrants	0.03	0.03	0.04	0.44
All fall vagrants and non-vagrants	0.00	0.01	0.00	0.81

1970s, but vagrant proportions at the two sites indicate that vagrants are probably less frequent at Big Sur than at Southeast Farallon Island. The proportion of vagrant captures at Big Sur might be more similar to Palomarin Field Station, at Point Reyes National Seashore just north of San Francisco, where a fair number of vagrant species, but < 1% of all birds, were captured from 1976 through 1986 (Taylor et al. 1994).

I found a decline in vagrant capture rates, particularly for northern vagrants, at Big Sur, but this trend might be at least partially associated with the decline in banding effort. Low vagrant capture rates in the final two years, during a period when banding effort was lowest, contributed to the negative trends for all vagrants and northern vagrants. Using capture rates rather than absolute vagrant numbers helped account for variability in effort, but when studying infrequent events such as vagrant occurrences, a reduction in sampling effort can render results less representative of actual rates. Closing the station in the winter accounted for part of the reduction in effort during the last three years. Because relatively few vagrants occurred during the winter, the lack of winter effort in 2009 and 2010 could have biased the capture rates high, rather than low, relative to other years. Therefore, the role of reduced sampling effort in negative vagrant trends at Big Sur is unclear.

If vagrant trends at Big Sur are largely independent of variability in effort, the decline in vagrant occurrences might be associated with declines in source populations for these species and/or declines in the proportion of vagrant individuals in source populations. Veit (2000) provided support for the idea that vagrancy is driven by population growth. If Big Sur vagrant trends are associated with source population trends, negative population trends should be more evident for the northern species captured than for the southeastern species. To evaluate this, I analyzed breeding bird survey results from 1993-2007 (Sauer et al. 2008), using a linear regression approach based on estimating equations, and found some support for an association. Of the 24 northern vagrant species captured at Big Sur, 12 declined significantly survey-wide, while four increased significantly. The remaining eight species had stable or non-significant trends, or were not adequately covered by surveys. Of the 15 southeastern vagrants captured at Big Sur, only three declined significantly, while six increased. The remaining six species had stable or non-significant trends. Population trends for some northern birds have been associated with periodic outbreaks of spruce budworm. Holmes and Sanders et al. (2009) found that numbers for many forest species increased as budworm densities increased, although songbird populations reached their peak at least five years before budworm densities reached their peak in 1990. Based on this chronology, spruce budworm densities and populations of several associated bird species were likely declining as my study began. Because budworm density can be an excellent predictor of vagrant occurrences for several warbler species in California (Patten and Burger 1998), such population declines could have contributed to the negative trend found for northern vagrants at Big Sur.

Several factors could influence the proportion of vagrant individuals in populations of these species. Able (1972) speculated that levels of toxic chemicals in the environment might affect the number of vagrants, perhaps by compromising orientation or the ability of birds to properly navigate. DeSante (1983) offered several hypotheses to explain vagrant trends, one of which linked rates of habitat change to the proportion of vagrant individuals in populations. Both hypotheses were presented as explanations for apparent increases in vagrant occurrences observed in the past. Either could have contributed to an increase in vagrant occurrences, but their association with decreasing vagrant trends is difficult to support. McLaren (1981) and Patten and Marantz (1996) considered that vagrant trends in Nova Scotia and California, respectively, were associated with range expansions for some species, although these processes were not exclusive, in their estimation, of changes in abundance. Patten and Marantz (1996), while suggesting that ranges of some southeastern species might be expanding, noted that northern vagrants were recorded with decreasing frequency in California, a pattern supported by Big Sur data over 18 subsequent years. I did not find a significant increase in southeastern vagrants that would support the idea of range expansion, but neither did I find a decline for that group.

Weather disturbances can also affect the proportion of vagrants in a population. Kaufman (1977) suggested that navigation error is more important than weather in causing vagrancy, but storms might displace individuals, and prevailing winds can abet navigation error in misoriented birds. Anomalous weather patterns have been linked to influxes of vagrants in some years (DeSante 1983, Patten and Marantz 1996). An unusually strong El Niño in the winter of 1997-1998 was perhaps responsible for exceptional capture rates of migrants at Big Sur in 1998, including vagrants. This apparent influx of migrants early in the study likely contributed to the negative vagrant trend. I repeated regressions with 1998 captures removed, and the negative trend for northern vagrants remained significant ($P=0.01$), whereas the trend for all vagrants was near, but no longer, significant ($P=0.07$). Therefore, I consider that weather patterns had some effect on vagrant trends at Big Sur, but multiple factors likely contributed to the negative trend for northern vagrants and the stable trend for southeastern vagrants.

I consider it likely that vagrant trends in California are at least partially associated with increases and decreases in source populations. Because most vagrant captures at Big Sur were young birds, changes in productivity might affect vagrant trends. Reduced productivity could limit the number of young birds migrating in the fall, thereby reducing the source pool of birds that become misoriented. Although negative breeding bird survey trends for many northern species provide some support for an association between vagrant trends at Big Sur and source populations, this association is probably not a simple one, given the uncertain role of sampling variability, weather, and other processes. However, vagrant studies can complement long-term monitoring projects by further documenting the distribution of vagrants and evaluating temporal associations between vagrants and source populations.

ACKNOWLEDGMENTS

I thank the Ventana Wildlife Society staff members, coordinators, banding technicians, and volunteers for their dedication to operating the station for 18 years. Craig Hohenberger founded the station in 1992. Jim Booker, Jeff Davis, Jessica Griffiths, Thomas Leeman, Karen Shihadeh, Sarah Hamilton, and Nellie Thorngate served as station coordinators. I thank Don Roberson for traveling to the station numerous times and verifying identification for some of the more unusual vagrants. I also thank the agencies and organizations which provided funding, including Monterey Peninsula Audubon Society, California Department of Parks and Recreation, Monterey Peninsula Water Management District, Community Foundation for Monterey County, and the David and Lucile Packard Foundation.

REFERENCES

Able, K. T. 1972. The changing seasons: fall 1971. American Birds 26:25-30.

California Bird Records Committee (R. A. Hamilton, M. A. Patten, and R. A. Erickson, eds.). 2007. Rare Birds of California. Western Field Ornithologists, Camarillo, California.

DeBenedictis, P. 1971. Wood warblers and vireos in California: the nature of the accidental. California Birds 2:111-128.

DeSante, D. F. 1973. An analysis of the fall occurrences and nocturnal orientations of vagrant wood warblers (Parulidae) in California. Ph.D. dissertation. Stanford University, Palo Alto, California.

DeSante, D. F. 1983. Annual variability in the abundance of migrant landbirds on Southeast Farallon Island, California. Auk 100:826-852.

DeSante, D. F., and D. G. Ainley. 1980. The avifauna of the South Farallon Islands, California. Studies in Avian Biology No. 4, Cooper Ornithological Society.

Holmes, S. B., and Sanders, C. J., D. Fillman, and D. A. Welsh. 2009. Changes in a forest bird community during an outbreak cycle of the spruce budworm in Northwestern Ontario. Bird Populations 9:13-28.

Kaufman, K. 1977. The changing seasons: an intimate look at Kathleen and other avian phenomena of autumn, 1976. American Birds 31:142-152.

McLaren, I. A. 1981. The incidence of vagrant landbirds on Nova Scotian Islands. Auk 98:243-257.

Patten, M. A., and J. C. Burger. 1998. Spruce budworm outbreaks and the incidence of vagrancy in eastern North American wood-warblers. Canadian Journal of Zoology 76:433-439.

Patten, M. A., and C. A. Marantz. 1996. Implications of vagrant southeastern vireos and warblers in California. Auk 113:911-923.

PIKE, J. E., AND D. M. COMPTON. 2010. The 34th report of the California Bird Records Committee: 2008 records. Western Birds 41:130-159.

PYLE, P. 1997. Identification guide to North American Birds. Part 1 Columbidae to Ploceidae. Slate Creek Press, Bolinas, California.

ROBERSON, D. 2002. Monterey Birds: Status and Distribution of Birds in Monterey County, California, 2nd edition. Monterey Peninsula Audubon Society, Carmel, California.

ROTTENBORN, S. C., AND J. MORLAN. 2000. Report of the California Bird Records Committee: 1997 records. Western Birds 31:1-37.

SAUER, J. R., J. E. HINES, AND J. FALLON. 2008. The North American breeding bird survey, results and analysis 1966-2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, Maryland.

SHUFORD, W. D. 1981. A note on assessing the status of vagrant warblers on the California coast. American Birds 35:264-266.

TAYLOR, D. M., D. F. DESANTE, G. R. GEUPEL, AND K. HOUGHTON. 1994. Autumn populations of landbirds along central coastal California 1976-1986. Journal of Field Ornithology 65:169-185.

VEIT, R. R. 2000. Vagrants as the expanding fringe of a growing population. Auk 117:242-246.

VENIER, L. A., J. L. PEARCE, D. R. FILLMAN, D. K. MCNICOL, AND D. A. WELSH. 2009. Effects of spruce budworm (*Choristoneura fumiferana* (Clem.)) outbreaks on boreal mixed-wood bird communities. Avian Conservation and Ecology – Ecologie et Conservation des Oiseaux 4:3. [online] URL: http://www.ace-eco.org/vol4/iss1/art3/.

APPENDIX 1. Number of captures by month for northern (NO), southeastern (SE), southwestern (SW), and palearctic (PA) vagrant birds at Big Sur, California, 1993-2010.

Species	Region	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Yellow-billed Cuckoo	SW						2	1						3
Red-naped Sapsucker	SW		1								1	1		3
Least Flycatcher	NO									4				4
Eastern Phoebe	NO											1		1
Great Crested Flycatcher	NO										1			1
White-eyed Vireo	SE						2							2
Bell's Vireo	SW									1				1
Yellow-throated Vireo	SE					1		1						2
Blue-headed Vireo	NO									1				1
Philadelphia Vireo	NO									2	2			4
Red-eyed Vireo	NO					1		5	1	6				13
Yellow-green Vireo	SW									1				1
Dusky Warbler	PA										1			1
Arctic Warbler	PA									1				1
Veery	NO									1				1
Gray Catbird	NO						2	1						3
Blue-winged Warbler	SE						1			1				2
Tennessee Warbler	NO				1	2	1			3	2			9
Virginia's Warbler	SW									1				1
Lucy's Warbler	SW											1		1
Northern Parula	SE					2	6	6	2					16
Chestnut-sided Warbler	NO					1	3			6	3			13
Magnolia Warbler	NO									6	14	1		21
Black-throated Blue Warbler	SE										1	2		3
Black-throated Green Warbler	NO									1		3		4
Prairie Warbler	SE										1			1
Palm Warbler	NO				1						9	1		11
Blackpoll Warbler	NO									16	10			26
Cerulean Warbler	SE										1			1
Black-and-white Warbler	NO				1	4	1	1		4	9		1	21
American Redstart	NO						5		1	6	1			13
Prothonotary Warbler	SE					1	2				2			5
Worm-eating Warbler	SE									1	1			2
Ovenbird	NO					1	3			2	1			7
Northern Waterthrush	NO					7			2	11				20
Louisiana Waterthrush	SE					1								1
Kentucky Warbler	SE					2								2
Connecticut Warbler	NO										1			1
Mourning Warbler	NO					1				4				5
Hooded Warbler	SE					4	13		1					18
Canada Warbler	NO						1				1			2
Summer Tanager	SW					1	1							2
Green-tailed Towhee	SW									2				2
American Tree Sparrow	NO											1		1
Clay-colored Sparrow	NO					1				3	3			7
Black-throated Sparrow	SW								1					1
Rose-breasted Grosbeak	NO					9	22	5	1	3				40
Indigo Bunting	SE					3	1				1			5
Painted Bunting	SE								1	3				4
Orchard Oriole	SE									1				1
Total		0	1	0	3	42	66	20	10	91	66	11	1	311